PEDIATRIC CARDIAC SURGERY: EFFECT OF A MINIATURIZED BYPASS CIRCUIT IN REDUCING HOMOLOGOUS BLOOD TRANSFUSION

To the Editor:

I read with great interest the excellent article by Koster and colleagues.[1] We have recently published our experience in treating 150 pediatric patients with a 120-mL prime volume miniaturized bypass circuit, vacuum-assisted venous drainage, and intermittent warm blood microplegia.[2] Our results, although less impressive than those of Koster and colleagues,[1] confirmed the efficiency of a small prime volume for reduction of allogeneic blood transfusion. With a nadir hemoglobin value of 8 g/dL during cardiopulmonary bypass, we demonstrated the good tolerance of hemodilution using 2 markers: preoperative and postoperative lactate levels (which were lower in patients undergoing bloodless surgery than in transfused patients) and time to extubation (which was shorter in patients undergoing bloodless surgery than in transfused patients). Our major concern was to not counterbalance the potential benefit of bloodless surgery by altering the intraoperative or postoperative care, thus inducing other risks. We firmly believe that transfusion cannot be the only outcome end point in such a study group.

Pediatric perfusion is a challenging technique with conflicting goals. The benefit expected from reducing transfusion requirements is a better immediate outcome at a lower cost.[3] On the other hand, a too low hematocrit level is hazardous, and less than 23.5% is said to be associated with lower Psychomotor Development Index scores and increased lactate levels.[4] In the literature the need for some norepinephrine bolus, increased inotropic support, increased ventilation time, and increased length of critical care or hospitalization stay have all been related to low perioperative hematocrit levels.

In Koster and colleagues' study group,[1] the factor triggering blood transfusion during surgical intervention was clearly a hemoglobin value of less than 7 g/dL. However, the triggering factor was less clear for the 4 patients transfused during the further course. The rationale to tolerate the same nadir level of 7 g/dL of hemoglobin during surgical intervention in patients with large differences in preoperative hemoglobin levels (from 11.1 g/dL [the lowest level in the study] to 16.0 g/dL [the highest level in the study]) is not obvious. Similarly, the technique used to reverse the intraoperative anemia and reach the postoperative hemoglobin target values, namely 8 to 10 g/dL in patients with anatomic correction and 12 to 16 g/dL in cyanotic patients with palliative procedures, is unclear.

Even if 85% of the patients were finally transfused, Koster and colleagues[1] are to be congratulated for their energy in promoting bloodless neonatal surgery. The efficiency of the miniaturized bypass circuit in reducing blood transfusion is well established. However, the link between bloodless surgery and improved immediate clinical outcome has yet to be confirmed, as has its lack of harm on late neurological outcome.

Yves Dominique Durandy, MD
Intensive Care Unit
Institut Jacques Cattier
Massy, France

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Reply to the Editor:

We thank Dr Durandy very much for her comments. We completely agree that performing transfusion-free surgery cannot be a goal in itself. There are convincing data from the adult world and first data from the pediatric world of cardiac surgery showing that transfusion of allogeneic blood impairs clinical outcomes. However, the small scale of our investigation and the great heterogeneity of cardiac malformations meant that the study was not powered to perform an assessment in this regard.

As you outlined, in addition to the technical aspects of the perfusion technique and the cardiopulmonary bypass (CPB) setup, definition of the critical hemoglobin value as a trigger for transfusion remains a key question. As you outlined, Jonas and coleagues[1] reported adverse neurological outcomes in patients with a hematocrit level of less than 20%, whereas a hematocrit level of 24% was safe.[2] In these patients surgical intervention was performed during deep hypothermic cardiac arrest or with low-flow CPB. In our investigation only 6 patients underwent deep hypothermia. However, we performed regional arterial cerebral perfusion and continuous measurement of cerebral oxygenation using near-infrared spectroscopy, which is an established monitoring tool under these circumstances.[3,4] Therefore

under these controlled conditions, we consider a hemoglobin value of greater than 7 g/dL (hematocrit level, >21%) to be safe. However, as you can see in Figure 2 of our article, only 1 patient had a hemoglobin value of less than 8 g/dL (hematocrit level, 24%).

During CPB, we defined the critical hemoglobin value as 7 g/dL, regardless of the preoperative hemoglobin value and regardless of the cardiac malformation of the patient. The target hemoglobin values after CPB depended on whether (near-) anatomic correction with physiologic perfusion of the lungs was achieved (critical hemoglobin value, 8–10 g/dL) or only palliation (critical hemoglobin value, 12–16 g/dL) was established. The higher target hemoglobin value of 12 to 16 g/dL was responsible for the observation that all patients with cyanotic malformations and nonanatomic correction of lung perfusion had to receive transfusion before termination of CPB or during the further course. In contrast, in most of the other patients, reinfusion of the remaining CPB volume, processed and concentrated with a special pediatric small-bowl cell saver, was effective in establishing or maintaining the target hemoglobin value of 8 to 10 g/dL.

I have studied your recently published article with great interest and appreciate that you were able to confirm in a larger number of patients, using a comparable perfusion technique (vacuum assisted venous drainage) and CPB setup to ours (same oxygenator but not the arterial filter that we require), that miniaturized CPB contributes to improved clinical outcomes.[5] Establishing large pools of data with comparable perfusion techniques will help to generate safety standards for CPB during this complex operation and assess which clinical parameters and monitoring techniques (especially near-infrared spectroscopy) are useful in the decision of whether to transfuse. Additionally, these data will help to define clearer outcome parameters because, for example, serum lactate concentrations might not be feasible in this regard as a result of the high concentration of lactate in stored packed red blood cell concentrates, whereas the duration of mechanical ventilation and stay in the intensive care unit might well be acceptable.

I hope that these lines contributed to a better understanding of our article and look forward to seeing more data from your interesting work in the near future.

Andreas Koster, MD[a]
Michael Huebler, MD[b]
Roland Hetzer, MD, PhD[b]
[a]*Deutsches Herzzentrum Baden Lahr, Germany*
[b]*Deutsches Herzzentrum Berlin Berlin, Germany*

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A NEW DIAGNOSTIC ALGORITHM FOR ASSESSMENT OF PATIENTS WITH SINGLE VENTRICLE BEFORE A FONTAN OPERATION

To the Editor:

We read with interest the article of Prakash and associates entitled ''A new diagnostic algorithm for assessment of patients with single ventricle before Fontan operation.''[1] We found it appealing to spare these children invasive and costly procedures in the era of rampant health care costs. In their retrospective study the authors developed an algorithm that identifies high-risk patients for the completion of partial cavopulmonary connection. This algorithm is based on clinical and noninvasive imaging criteria and limits cardiac catheterization only to high-risk patients.

We and others believe that the major indication for cardiac catheterization in patients with partial cavopulmonary connection is to measure the pulmonary arterial pressure. Left ventricular function and pulmonary arterial pressure are the 2 most important criteria in identifying patients at risk for the completion of the Fontan procedure.[2] Should we assume that all patients with normal pulmonary artery size and normal ventricular function in the absence of pulmonary branch stenosis have acceptable levels of pulmonary artery pressure?

Ba and colleagues[3] found in their report that clinical signs identified only a minority of patients in whom the Fontan procedure was contraindicated and detected a subgroup of patients with normal pulmonary artery size and high pulmonary artery pressure.

To this day, Fontan-like procedures are the only option for patients with a single ventricle. If the completion of a cavopulmonary connection is contraindicated, the patient is usually scheduled for heart transplantation. On the other hand, failure of the total cavopulmonary connection or its takedown is usually followed by a stormy postoperative course and a high mortality rate. Hence we believe that the decision to proceed to a total cavopulmonary connection is extremely delicate; cardiac catheterization remains the gold standard for the contraindication of a total cavopulmonary connection until comparative prospective